Environment Canada Environnement

Return flow report for irrigation districts i
n Alberta
Dated 1990

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CONSERVATION & PROTECTION

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WATER RESOURCES BRANCH
ALBERTA DISTRICT

1990 RETURN FLOW REPORT

FOR

IRRIGATION DISTRICTS IN ALBERTA

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SYNOPSIS

This report summarizes hydrometric data relating to the use of diverted water by irrigation projects in Alberta, and continues the series of Return Flow reports initiated in 1956 at the request of the Prairie Provinces Water Board.

Three components are determined for each irrigation district: the net diversion, the return flow, and the consumptive use.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
PROCEDURE	2
IRRIGATION SUMMARY - 1990	10
ACKNOWLEDGEMENTS	14
REFERENCES	15

TABLES

TABLE 1: Summary of Diversion, Return Flow, Hectares Irrigated, and Consumptive Use	11
TABLE 2: History of Hectares Irrigated	12
TABLE 3: History of Consumptive Use	13

APPENDIX A (Summaries of Monthly Diversions and Return Flow by Project)	A1
TABLE A1: Eastern Irrigation District Monthly Diversion	A2
TABLE A2: Eastern Irrigation District Return Flow	A2
TABLE A3: Western Irrigation District Monthly Diversion	A3
TABLE A4: Western Irrigation District Return Flow	A3
TABLE A5: Bow River Irrigation District Monthly Diversion	A4
TABLE A6: Bow River Irrigation District Return Flow	A4

TABLE OF CONTENTS

(cont'd)

Page

APPENDIX A (cont'd)

TABLE A7: St. Mary River Irrigation District Monthly Diversion A5

TABLE A8: St. Mary River Irrigation District Return Flow. . A5

TABLE A9: Lethbridge Northern Irrigation District Monthly Diversion A6

TABLE A10: Lethbridge Northern Irrigation District Return Flow A6

TABLE A11: United Irrigation District Monthly Diversion. . . A7

TABLE A12: United Irrigation District Return Flow A7

TABLE A13: Mountain View & Leavitt-Aetna Irrigation District Monthly Diversion A8

TABLE A14: Mountain View & Leavitt-Aetna Irrigation District Return Flow A8

INTRODUCTION

Monthly diversions and return flows were determined for the following irrigation districts:

1. Mountain View
2. Leavitt
3. Aetna
4. United
5. Magrath
6. Raymond
7. Lethbridge Northern
8. Taber
9. St. Mary River
10. Bow River
11. Western
12. Eastern

Prior to 1972, irrigation statistics for only the Western, Eastern and Bow River Irrigation Districts were published in the return flow reports, but from 1972 onward, statistics for all twelve irrigation districts have been included in the annual reports. For ease of tabulation and handling, statistics for the Taber, Raymond, Magrath and St. Mary Irrigation Districts were combined as were those of the Mountain View, Leavitt and Aetna Irrigation Districts.

The basic purpose of this report is to compile the irrigation diversion, return flow and consumptive use statistics for each of the irrigation districts in 1990 for comparison with similar statistics of preceding years. This report contains a section on procedures used in determining return flow, a section summarizing the irrigation statistics in 1990 and three tables presenting irrigation statistics since 1972. The appendices contain a number of tables presenting the monthly diversions and return flows by project during 1990.

P R O C E D U R E

Up to 1972, return flows for the Bow River, Eastern and Western Irrigation Districts were determined by adjusting the gauged or estimated return flows for precipitation runoff occurring during the irrigation season (usually May to October). A study of the actual natural runoff showed this to be an insignificant portion of the total monitored return flow (less than monitoring accuracy) and thus from 1972 to 1988, the return flow for these three irrigation districts was determined by totalling the gauged and estimated return flows without making precipitation runoff adjustments.

The large number of return flow channels precludes the continuous monitoring of them all. Stream gauges are located on most of the major return flow channels and some of the minor ones. In 1971 and 1972 these data were supplemented by periodic miscellaneous measurements of all the ungauged return flow channels. Utilizing all these data, procedures were developed to estimate total return flow for each of the irrigation districts. These procedures are detailed in the report "Determination of Irrigation Return Flow in Southern Alberta, March 1974", approved by the Committee on Hydrology, Prairie Provinces Water Board and were used through 1984, inclusive.

Because of changes in irrigation practices, primarily a changeover to mechanical sprinkler systems during the mid-1970's, it was felt that a change in return flow patterns had occurred. Therefore, comprehensive field programs were conducted in 1979 and 1981. The results from these programs were utilized in deriving new

procedures for estimating total return flow, which were used for the first time in 1985. These procedures are detailed in the report "Return Flow from Irrigation, Southern Alberta, October 1985, P.P.W.B. Report No. 72".

A comprehensive field program was conducted during 1986 and 1987 in the Eastern, Bow River and Western irrigation districts. The data from these programs were utilized to derive new procedures for estimating total return flow, which were used for the first time in 1989.

All procedures for the determination of return flow are detailed in the report, "Return Flow from Irrigation Districts in South Saskatchewan River Basin, September 1989, P.P.W.B. Report No. 72."

Following are brief descriptions of the procedures utilized to determine return flow for 1990 for each of the irrigation districts. Procedures for earlier years are described in previous annual reports.

Eastern Irrigation District

The monthly return flows from the Eastern Irrigation District are calculated utilizing a series of multiple regression equations, which use data from four stream gauging stations.

The regression equations are as follows:

May RF = $3266.9 + 1.609X_1 + 2.492X_2 + 1.193X_3 + 1.217X_4$

June RF = $18\ 214.2 + 1.404X_1 + 0.000X_2 + 0.000X_3 + 1.230X_4$

July RF = $-3714.6 + 1.820X_1 + 0.000X_2 + 1.917X_3 + 1.238X_4$

August RF = $5708.2 + 1.061X_1 + 0.000X_2 + 0.903X_3 + 1.870X_4$

September RF = $-593.1 + 1.790X_1 + 7.468X_2 + 1.577X_3 + 1.063X_4$

October RF = $-593.1 + 1.790X_1 + 7.468X_2 + 1.577X_3 + 1.063X_4$

Where:

RF = monthly return flow in cubic decameters

X_1 = monitored monthly volume for Twelve Mile Creek near Cecil (05BN002)

X_2 = monitored monthly volume for Coal Creek at Bow City (05BN014)

X_3 = monitored monthly volume for Onetree Creek near Patricia (05CJ006)

X_4 = monitored monthly volume at Matzhiwin Creek below Ware Coulee (05CJ012)

The above regression equations were first used in the 1989 report, and gives higher return flow volumes than previous regression equations.

Western Irrigation District

The monthly return flows from the Western Irrigation District are calculated utilizing a series of multiple regression equations which use data from four stream gauging stations.

The regression equations are as follows:

May RF = $411.8 + 0.917X_1 + 1.099X_2 + 1.035X_3 - 1.134X_4$

June RF = $971.3 + 0.000X_1 + 0.915X_2 + 1.086X_3 + 0.000X_4$

July RF = $3045.2 + 0.000X_1 + 0.970X_2 + 0.959X_3 + 0.000X_4$

August RF = $1365.5 + 0.000X_1 + 1.073X_2 + 1.119X_3 + 0.000X_4$

September RF = $270.0 + 0.000X_1 + 1.975X_2 + 0.937X_3 + 0.000X_4$

October RF = $270.0 + 0.000X_1 + 1.975X_2 + 0.937X_3 + 0.000X_4$

Where:

RF = monthly return flow in cubic decameters

X_1 = monitored monthly volume at Hammer Hill Spillway near Gleichen (05BM005)

X_2 = monitored monthly volume at Crowfoot Creek near Cluny (05BM008)

X_3 = monitored monthly volume at Rosebud River at Redland (05CE005)

X4 = monitored monthly volume at Rosebud River below Carstairs Creek (05CE006)

The above regression equations were first used in the 1989 report.

Bow River Irrigation District

The monthly return flows from the Bow River Irrigation District are calculated utilizing a series of multiple regression equations which use data from four stream gauging stations.

The regression equations are as follows:

May RF = $1480.9 + 1.711X_1 + 4.353X_2 + 0.683X_3 + 1.310X_4$

June RF = $-8211.5 + 6.708X_1 + 0.000X_2 + 0.000X_3 + 0.000X_4$

July RF = $9045.2 + 0.000X_1 + 0.000X_2 + 0.000X_3 + 5.071X_4$

August RF = $8078.1 + 0.000X_1 + 0.000X_2 + 0.299X_3 + 3.553X_4$

September RF = $4621.0 + 1.730X_1 + 0.000X_2 + 0.000X_3 + 1.975X_4$

October RF = $4621.0 + 1.730X_1 + 0.000X_2 + 0.000X_3 + 1.975X_4$

Where:

RF = monthly return flow in cubic decameters

X_1 = monitored monthly volume at Expanse Coulee near the Mouth (05AG003)

X_2 = monitored monthly volume at B.R.I.D. Drain "A" near Hays (05AG004)

X_3 = monitored monthly volume at Nev West Coulee near the Mouth (05BN006)

X_4 = monitored monthly volume of B.R.I.D. Drain "D" near Vauxhall (05BN008)

The above regression equations were first used in the 1989 report.

St. Mary River Irrigation District

For ease of tabulation and handling, the data for the Taber, Raymond, Magrath and St. Mary River Irrigation Districts are combined under the heading St. Mary River Irrigation District.

The return flow data are calculated based on a multiple regression equation plus the total monitored flow in Pothole Creek at Russell's Ranch and Dry Coulee near Magrath.

The regression equation utilized is:

$RF = 3354.6 + 1.251X_1 + 3.488X_2 + 2.512X_3 + 2.318X_4 + 2.604X_5 + 1.628X_6$*

where:

RF = total monthly return flow in cubic decameters and the regression equation utilizes total recorded monthly flow in cubic decameters at the following stations:

X_1 = Seven Persons Creek at Medicine Hat (05AH005)

X_2 = Drain S-6 near Bow Island (05AJ004)

X_3 = Drain S-10 near Bow Island (05AJ003)

X_4 = Drain T-1 near Taber (05AG027)

X_5 = Bountiful Coulee Inflow near Cranford (05AG026)

X_6 = Ross Creek at Medicine Hat (05AH049)

In 1972, not all the gauging stations utilized in the regression equation were operating on a continuous basis and therefore total return flows were calculated on the basis of the miscellaneous measurements made at those particular sites.

* This is the equation which should have been shown in the 1987, '88, and '89 editions of this report; however, the numbers shown are correct.

Lethbridge Northern Irrigation District

The monthly return flows from the Lethbridge Northern Irrigation District are calculated utilizing a multiple regression equation which uses data from five stream gauging stations.

The regression equation is as follows:

$$RF = 338.34 + 0.955X_1 + 1.308X_2 + 1.237X_3 - 1.251X_4 + 0.830X_5$$

where:

RF = monthly return flow in cubic decameters

X_1 = monitored monthly volume at Piyami Drain near Picture Butte (05AD037)

X_2 = monitored monthly volume at Battersea Drain near the Mouth (05AD038)

X_3 = monitored monthly volume at Little Bow River near the Mouth (05AC023)

X_4 = monitored monthly volume at Little Bow River below Travers Dam (05AC012)

X_5 = monitored monthly volume at Drain L-5 near Diamond City (05AD090)

Data for the Battersea Drain and Little Bow River near the Mouth sites were not available for 1972. The monthly return flow data were calculated based on miscellaneous measurements taken at these sites in 1972.

United Irrigation District

The return flow data from the United Irrigation District are calculated based on varying monthly percentages of the monitored diversion (United Irrigation District Canal near Hillspring). The percentages from May to October, respectively, are 100, 100, 35, 30, 25 and 20.

Mountain View and Leavitt-Aetna Irrigation Districts

The return flows from these districts are also based on varying monthly percentages of the total diversion (Mountain View Irrigation District Canal). The respective percentages from May to October are 100, 100, 40, 35, 20 and 35.

IRRIGATION SUMMARY - 1990

The total monitored diversions to the irrigation districts in 1990 was 2 474 000 dam^3 compared to 2 506 000 dam^3 in 1989, a one percent decrease in diversion.

The total return flow in 1990 was 580 000 dam^3 or twenty-three percent of the total diversion. In 1989 the total return flow was 520 000 dam^3, which was twenty-one percent of the total diversion. The consumptive use in 1990 was 1 894 000 dam^3, while in 1989 consumptive use was 1 955 000 dam^3. The consumptive use expressed in terms of dam^3/hectare was 4.36 in 1990 as compared to 4.53 in 1989. This consumptive use of 4.36 dam^3/hectare is equal to the mean consumptive use (1972-1989 inclusive). Total hectares irrigated in 1990 were 434 670 as compared to 431 290 in 1989.

Table 1 presents a summary of total diversions, return flows, hectares irrigated and consumptive use for the respective irrigation districts. A historical listing (since 1972) of hectares irrigated in each irrigation district is presented in Table 2. Table 3 is a listing of total consumptive use since 1972.

TABLE 1

SUMMARY OF DIVERSION, RETURN FLOW, HECTARES IRRIGATED, AND CONSUMPTIVE USE

Irrigation District	Total Diversion (dam^3)	Return Flow (dam^3)	Return Flow % of Diversion	Hectares Irrigated	Consumptive Use (dam^3)	Consumptive Use (dam^3/ha)
Eastern Irrigation District	816 990	250 290	31	102 490	566 700	5.53
Western Irrigation District	157 760	78 240	50	19 830	79 520	4.01
Bow River Irrigation District	465 420	101 890	22	68 860	363 530	5.28
St. Mary River* Irrigation District	760 500	104 110	14	182 770	656 390	3.59
Lethbridge Northern Irrigation District	236 700	31 710	13	51 820	204 990	3.96
United Irrigation District	19 920	7 340	37	4 660	12 580	2.70
Mountain View and Leavitt-Aetna Irrigation District	17 100	6 420	38	4 240	10 680	2.52
TOTAL	2 474 390	580 000	23	434 670	1 894 390	4.36

* Includes Taber, Raymond and Magrath Irrigation Districts

Note: In 1989 the total Diviersion for B.R.I.D. was in error as it included the summation of Little Bow River at Carmangay and Little Bow Canal at High River. (i.e.; Little Bow River at Carmangay already includes water accounted for by Little Bow Canal.) Therefore, total Diversion for B.R.I.D. should have been 466 580 - 30 730 (Little Bow at Carmangay) = 435 850 dam^3.

TABLE 2

HISTORY OF HECTARES IRRIGATED

Year	Hectares Irrigated							
	EID	WID	BRID	SMRID*	LNID	UID	MVID**	TOTAL
1972	71 190	6 880	33 630	89 490	23 800	4 480	3 850	223 320
1973	74 170	7 690	39 740	127 490	37 620	9 000	4 200	299 930
1974	76 350	8 900	42 120	111 600	36 460	4 740	3 850	284 020
1975	72 480	13 780	39 790	96 360	28 680	2 000	3 500	256 590
1976	81 500	16 190	50 750	121 400	39 130	5 420	3 840	318 230
1977	84 500	19 630	53 170	138 400	40 190	13 500	4 230	353 620
1978	82 630	13 490	52 610	118 940	29 700	3 510	4 530	305 410
1979	86 540	18 850	54 030	141 800	46 850	13 260	4 530	365 860
1980	86 000	17 800	54 430	138 360	38 840	5 100	4 160	344 690
1981	87 490	11 490	56 980	141 980	38 750	6 100	4 160	346 950
1982	87 660	17 000	61 570	162 670	42 740	4 070	4 160	379 870
1983	93 530	18 870	65 400	159 450	43 760	5 320	4 250	390 580
1984	96 340	18 870	70 150	168 200	43 830	4 980	4 310	406 680
1985	96 580	20 100	70 820	171 980	46 390	5 110	3 960	414 940
1986	96 570	19 420	70 190	182 390	46 000	5 320	4 100	423 990
1987	94 550	19 010	70 380	183 070	47 730	5 070	3 620	423 430
1988	100 800	21 450	70 170	176 340	52 650	5 880	4 260	431 550
1989	101 020	21 100	70 170	179 240	51 400	4 730	3 630	431 290
1990	102 490	19 830	68 860	182 770	51 820	4 660	4 240	434 670

* Includes Taber, Raymond and Magrath Irrigation Districts

** Includes Leavitt and Aetna Irrigation Districts

TABLE 3

HISTORY OF CONSUMPTIVE USE

Year	Total Diversions (dam^3)	Total Return Flow (dam^3)	Total Return Flow % of Diversion	Consumptive Use (dam^3)	Unit Consumptive Use (dam^3/ha)
1972	1 661 000	548 000	33	1 113 000	4.77
1973	2 020 000	530 000	26	1 490 000	4.97
1974	1 889 000	512 000	27	1 377 000	4.85
1975	1 239 000	471 000	38	768 000	2.99
1976	2 050 000	570 000	28	1 480 000	4.65
1977	2 141 000	478 000	22	1 663 000	4.70
1978	1 270 000	436 000	34	834 000	2.73
1979	1 925 000	483 000	25	1 442 000	3.94
1980	1 999 000	554 000	28	1 445 000	4.19
1981	2 090 000	620 000	30	1 470 000	4.24
1982	1 929 000	618 000	32	1 311 000	3.45
1983	2 369 000	595 000	25	1 774 000	4.54
1984	2 639 000	545 000	21	2 093 000	5.15
1985	2 477 000	479 000	19	1 998 000	4.81
1986	2 384 000	574 000	24	1 810 000	4.27
1987	2 335 000	515 000	22	1 820 000	4.30
1988	2 886 000	529 000	18	2 357 000	5.46
1989*	2 476 000	520 000	21	1 955 000	4.53
Mean	2 099 000	532 000	25	1 567 000	4.36
1990	2 474 000	580 000	23	1 894 000	4.36

* See note on Page 11.

A C K N O W L E D G E M E N T S

The information which each of the irrigation districts and the Alberta Department of the Environment provided in the tabulatio and collection of streamflow area irrigated, and other data, is gratefully acknowledged. The irrigation districts are:

Aetna Irrigation District
Bow River Irrigation District
Eastern Irrigation District
Leavitt Irrigation District
Lethbridge Northern Irrigation District
Magrath Irrigation District
Mountain View Irrigation District
Raymond Irrigation District
St. Mary Irrigation District
Taber Irrigation District
United Irrigation District
Western Irrigation District

REFERENCES

Water Survey of Canada. "Return Flow Report", Annual Series 1956 to 1989.

Water Survey of Canada. "Determination of Irrigation Return Flow in Southern Alberta," March 1974, Technical Report No. 43 to P.P.W.B.

Water Survey of Canada. "Natural Flow - South Saskatchewan River below Red Deer River," March 1974, Technical Report No. 45 to P.P.W.B.

Water Resources Branch. "Return Flow from Irrigation, Southern Alberta," October 1985, Technical Report No. 72 to P.P.W.B.

Water Resources Branch. "Return flow from Irrigation Districts in South Saskatchewan River Basin," September 1989, Technical Report No. 72 to P.P.W.B.

APPENDIX A

SUMMARIES OF MONTHLY DIVERSIONS AND RETURN FLOW BY PROJECT

EASTERN IRRIGATION DISTRICT

TABLE A1

1990 Monthly Diversion
(Cubic Decameters)

	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	TOTAL
North Branch Canal near Bassano	150	10 180	14 380	25 170	24 980	21 490	6 310	0	102 660
East Branch Canal near Lathom	25 860	84 600	85 410	112 430	108 670	78 630	31 670	0	527 270
Springhill Canal near Lathom	0	21 390	37 460	63 510	35 620	21 440	7 640	0	187 060
TOTAL DIVERSION 816 990									

TABLE A2

1990 Return Flow
(Cubic Decameters)

	April	May	June	July	August	September	October
Return Flow	8 040	26 960	44 230	70 360	47 180	30 900	22 620
TOTAL RETURN FLOW 250 290							

WESTERN IRRIGATION DISTRICT

TABLE A3

1990 Monthly Diversion

(Cubic Decameters)

Western Irrigation District Canal near Chestermere Lake	April	May	June	July	August	September	October	November
	2 240	22 410	23 040	45 890	38 530	25 210	360	80
	TOTAL DIVERSION 157 760							

TABLE A4

1990 Return Flow

(Cubic Decameters)

	April	May	June	July	August	September	October	November
Return Flow	4 730	8 250	22 670	14 150	14 260	10 020	4 160	0
	TOTAL RETURN FLOW 78 240							

BOW RIVER IRRIGATION DISTRICT

TABLE A5

1990 Monthly Diversion

(Cubic Decameters)

	April	May	June	July	August	September	October
Bow River Development Main Canal	32 670	67 090	59 740	89 780	88 030	86 540	19 910
Highwood Diversion Canal near Headgates	0	1 420	1 900	3 750	1 550	950	420
Little Bow Canal at High River	1 580	3 490	3 860	6 970	3 240	1 280	1 590
Little Bow River below Travers Dam	-1 810	-2 030	-1 890	-1 820	-1 220	- 800	- 770
Monthly Diversion	32 440	69 970	63 610	98 680	91 600	87 970	21 150
TOTAL DIVERSION 465 420							

TABLE A6

1990 Return Flow

(Cubic Decameters)

	April	May	June	July	August	September	October
Return Flow	1 910	7 000	13 590	27 610	20 780	19 080	11 920
TOTAL RETURN FLOW 101 890							

ST. MARY IRRIGATION DISTRICT
(INCLUDING TABER, RAYMOND & MAGRATH IRRIGATION DISTRICTS)

TABLE A7

1990 Monthly Diversion
(Cubic Decameters)

	April	May	June	July	August	September	October	Total
Canadian St. Mary Canal near Spring Coulee	9 720	72 860	114 420	229 360	151 250	136 790	34 610	749 010
Magrath Irrigation District Canal	0	50	540	5 000	2 630	2 460	810	11 490
TOTAL DIVERSION 760 500								

TABLE A8

1990 Return Flow
(Cubic Decameters)

	April	May	June	July	August	September	October
Return Flow	4 460	13 220	14 720	23 840	19 680	16 200	11 990
TOTAL RETURN FLOW 104 110							

Monthly return flow determined by utilizing regression equation, plus flow in Pothole Creek at Russel's Ranch and Dry Coulee near Magrath.

LETHBRIDGE NORTHERN IRRIGATION DISTRICT

TABLE A9

1990 Monthly Diversion
(Cubic Decameters)

L.N.I.D. Canal above Oldman Flume	April	May	June	July	August	September	October
	4 570	26 580	40 250	91 420	38 800	23 700	11 380
	TOTAL DIVERSION 236 700						

TABLE A10

1990 Return Flow
(Cubic Decameters)

	April	May	June	July	August	September	October
Return Flow	930	4 950	4 180	4 730	6 210	5 690	5 020
	TOTAL RETURN FLOW 31 710						

Monthly return flow determined by regression equation.

UNITED IRRIGATION DISTRICT

TABLE A11

1990 Monthly Diversion
(Cubic Decameters)

U.I.D. Canal	April	May	June	July	August	September	October
near Hill Spring	0	0	2 030	6 490	5 820	3 530	2 050
	TOTAL DIVERSION 19 920						

TABLE A12

1990 Return Flow
(Cubic Decameters)

	April	May	June	July	August	September	October
Return Flow	0	0	2 030	2 270	1 750	880	410
	TOTAL RETURN FLOW 7 340						

MOUNTAIN VIEW AND LEAVITT-AETNA IRRIGATION DISTRICTS

TABLE A13

1990 Monthly Diversion
(Cubic Decameters)

Mountain View Irrigation District Canal	April	May	June	July	August	September	October	November
	260	440	760	3 680	5 850	4 490	1 610	10
	TOTAL DIVERSION 17 100							

TABLE A14

1990 Return Flow
(Cubic Decameters)

	April	May	June	July	August	September	October	November
Return Flow	260	420	760	1 470	2 050	900	560	0
	TOTAL RETURN FLOW 6 420							